



FAA-E-2667  
January 5, 1977

# DEPARTMENT OF TRANSPORTATION

## FEDERAL AVIATION ADMINISTRATION

### SPECIFICATION

#### ROTARY JOINT, L-BAND, SIX SECTION

#### 1. SCOPE

**1.1 Scope.**- The equipment specified herein is an L-band rotary joint. Each rotary joint shall have six RF sections (channels), three of which shall be utilized by the **FPS-20/60** family of long range radar system and three of which shall be utilized by the **ATCRBS** (beacon) system. The rotary joint shall have an integral slip ring assembly and includes mechanical interface hardware for use with **FPS-20/60** long range radar systems.

#### 2. APPLICABLE DOCUMENTS

**2.1 General.**- The following specifications, standards, or other documentation form a part of this specification and are applicable in their entirety unless otherwise specified herein. The applicable issues of these specifications are listed in the invitation for bids or the request for proposals.

2.1.1 FAA specifications.-

**FAA-G-2100/1** Electronic Equipment, General Requirements;  
Part 1, Basic Requirements for all Equipments

**FAA-G-2100/1** ~~Amendment-1~~ **Amendment-2**

2.1.2 FAA standards.-

**FAA-STD-001** Color and Texture of Finishes for National  
Airspace System Equipment

**FAA-STD-002** Engineering Drawings

**FAA-STD-012** Paint Systems for Equipment

**FAA-STD-013** Quality Control Program Requirements

2.1.3 Military specifications.-

**MIL-E-1755G** Electronic and Electrical Equipment, Accessories,  
and Repair Parts, Packaging, and Packing of

**MIL-C-45662A** Calibration System Requirement

**MIL-I-45208A** Inspection System Requirements

**MIL-C-8514** Paint Primer

**MIL-P-23377** Epoxy Primer

**MIL-C-83286B** Enamel

2.1.4 Military standards.-

**MIL-STD-1229** Marking for Shipment and Storage

**MIL-STD-1285** Marking of Electrical and Electronic Parts

2.1.5 Other publications.- The following drawings of the issue in effect on the date of the invitation for bids or request for proposals shall form a part of this specification. This specification shall take precedence in the event of conflict.

DOT Order **1010.51A**, Selection Order: U.S. National Aviation Standard for the Mark X **(SIF)** Air Traffic Control Radar Beacon System **(ATCRBS)** Characteristics

**2.2 Instruction manuals.-** Manuals for **FPS-20/60** series long range radar equipments and the associated **AN/UPX-14** or **ATCBI-3** to 5 series beacon equipment, including modification documents, shall form a part of this specification to the extent specified herein. These manuals will not be furnished for use in preparation of proposals or bids; however, reference copies are available in the Department of Transportation Library, Building FOB **10A**, Washington, **D.C.**

**2.3 Order of precedence.-** In the event of an inconsistency in this contract, the inconsistency shall be resolved by giving precedence in the following order: **(a)** The contract schedule, **(b)** the General Provisions, **(c)** this specification, and **(d)** subsidiary documents referenced herein.

### **3. REQUIREMENTS**

**3.1 Summary of equipment to be furnished by the contractor.-** The contractor shall provide rotary joints in the quantities prescribed by the contract. Each rotary joint shall meet the electrical requirements stated herein. Each rotary joint shall have six RF sections (channels), three of which shall be utilized by the **FPS-20/60** family of long range radar system and three of which shall be utilized by the **ATCRBS** (beacon) system. All sections shall be constructed with noncontacting joints. All sections of the rotary joint shall transfer energy without change of polarization through **360** degrees rotation of the joint. The isolation between high power radar and beacon paths of the joint shall be no less than **60 dB**.

The rotary joint shall meet the parameters stated herein throughout **360** degrees of rotation.

**3.2 Environmental conditions and requirements.-** The rotary joint and **slip** ring assembly shall be designed for reliable and maintenance-free operation in the environment and weather extremes as specified below.

**3.2.1 Ambient service conditions.-** The ambient conditions shall be those given in **1-3.2.23** of **FAA-G-2100/1b** for Environment III, as specified below.

#### **3.2.1.1 Relative humidity.-**

**5%** to **100%** (including condensation due to temperature change)

#### **3.2.1.2 Temperature.-**

**-50°C** to **70°C**

#### **3.2.1.3 Wind conditions.-**

0 to **60** knots

#### **3.2.1.4 Ice loading.-**

Encased in **1/2** inch radial thickness clear ice on exposed portions.

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#### **3.2.1.3 Wind conditions.**-

0 to **60** knots

#### **3.2.1.4 Ice loading.**-

Encased in **1/2** inch radial thickness clear ice on exposed portions.

**Note 1:** Throughout the frequency range from **1026.5** to **1033.5 MHz**, the insertion loss of sections 4 and 5 shall be the same to within **0.1 dB** and the phase shift through these two sections shall be the same to within 5 degrees. Throughout the frequency range from **1085** to **1095 MHz**, the insertion loss of sections 4 and 6 shall be the same to within **0.1 dB** and the phase shift through these two sections shall be the same to within 5 degrees. Sections 4 and 6 shall meet the following additional requirements when a standard **ATCRBS** reply pulse having rise and fall times less than **55** nanoseconds is transmitted through these sections. The rise and fall times of the output pulses shall be less than **60** nanoseconds and the output pulses shall be flat to within **-15%** of their respective peak amplitudes over the pulse duration (that is, between the **90%** amplitude points on the leading and trailing edges). Between the **50%** and **90%** amplitude points on the leading and trailing edges of the output pulses, the pulse shapes in sections 4 and 6 shall be the same to within **+10%** of the output pulse amplitude of one of the two sections. **Between** the **90%** amplitude points on the leading and trailing edges of the output pulses, the two pulse shapes shall be the same to within **+5%** of the output pulse amplitude of one of the two sections. All **connectors** and waveguide ports supplied on the rotary joint shall be the same as those currently employed on **FPS-20/60** series radar rotary joints. The rotary joint shall be provided with weatherproof covers on all connectors and waveguide ports. Sections 3 and 6 shall be supplied with weatherproof RF terminations installed on the stationary input ports. The input and output connectors of section 4 shall be labeled "Beacon Directional". The input and output connectors of section 5 shall be labeled "**SLS**". The input and output connectors of section 6 shall be labeled "Monopulse". The input and output ports of sections 1 and 2 shall be labeled "High Power". The input and output ports of section 3 shall be labeled "Low Power". Standard **ATCRBS** reply pulse is defined in DOT Order **1010.51A**, Selection Order.

**3.3.2 Isolation.-** The isolation between each rotary joint section and all other rotary joint sections shall be **60 dB** or better.

**3.3.3 Slip ring assembly.-**

<u>Minimum No. of Circuits</u>	<u>Power Handling (120 volts, 60 Hz or DC)</u>
<b>10</b>	5 amps each circuit
3	<b>15</b> amps each circuit

The slip ring assembly shall be reliable and easily adjustable. Maximum rotation shall be **25** RPM. Terminal strips shall be provided to terminate both ends of the slip ring connections. The slip ring shall be an integral part of the rotary joint, but in any case, shall be readily accessible for inspection, adjustment, or replacement.

**3.4 Mechanical requirements.-**

**Note 1:** Throughout the frequency range from **1026.5** to **1033.5 MHz**, the insertion loss of sections 4 and 5 shall be the same to within **0.1 dB** and the phase shift through these two sections shall be the same to within 5 degrees. Throughout the frequency range from **1085** to **1095 MHz**, the insertion loss of sections 4 and 6 shall be the same to within **0.1 dB** and the phase shift through these two sections shall be the same to within 5 degrees. Sections 4 and 6 shall meet the following additional requirements when a standard **ATCRBS** reply pulse having rise and fall times less than **55** nanoseconds is transmitted through these sections. The rise and fall times of the output pulses shall be less than **60** nanoseconds and the output pulses shall be flat to within **-15%** of their respective peak amplitudes over the pulse duration (that is, between the **90%** amplitude points on the leading and trailing edges). Between the **50%** and **90%** amplitude points on the leading and trailing edges of the output pulses, the pulse shapes in sections 4 and 6 shall be the same to within **+10%** of the output pulse amplitude of one of the two sections. **Between** the **90%** amplitude points on the leading and trailing edges of the output pulses, the two pulse shapes shall be the same to within **+5%** of the output pulse amplitude of one of the two sections. All **connectors** and waveguide ports supplied on the rotary joint shall be the same as those currently employed on **FPS-20/60** series radar rotary joints. The rotary joint shall be provided with weatherproof covers on all connectors and waveguide ports. Sections 3 and 6 shall be supplied with weatherproof RF terminations installed on the stationary input ports. The input and output connectors of section 4 shall be labeled "Beacon Directional". The input and output connectors of section 5 shall be labeled "**SLS**". The input and output connectors of section 6 shall be labeled "Monopulse". The input and output ports of sections 1 and 2 shall be labeled "High Power". The input and output ports of section 3 shall be labeled "Low Power". Standard **ATCRBS** reply pulse is defined in DOT Order **1010.51A**, Selection Order.

**3.3.2 Isolation.**- The isolation between each rotary joint section and all other rotary joint sections shall be **60 dB** or better.

**3.3.3 Slip ring assembly.**-

<u>Minimum No. of Circuits</u>	<u>Power Handling (120 volts, 60 Hz or DC)</u>
<b>10</b>	5 amps each circuit
3	<b>15</b> amps each circuit

The slip ring assembly shall be reliable and easily adjustable. Maximum rotation shall be **25** RPM. Terminal strips shall be provided to terminate both ends of the slip ring connections. The slip ring shall be an integral part of the rotary joint, but in any case, shall be readily accessible for inspection, adjustment, or replacement.

**3.4 Mechanical requirements.**-

**3.4.3.2 Terminal block.**- The terminal strips shall be readily accessible and **in** a weather tight enclosure. The slip ring connector cable shall lead through a weather tight opening in the terminal block.

**3.4.3.2.1 Slip ring circuits.**-

(a) Stationary connector **MS3102R24-5P** shall be wired to brush terminals.

(b) Rotating connector **MS3102R24-5S** shall be wired to slip rings.

**3.4.3.2.2 Connector pin/socket.**- Connector pin/socket letters **A, B, C, D, E, F, H, J, K,** and **L** shall be connected to **5-ampere** rings; **N, P, R,** and **S** shall be connected to **15-ampere** rings.

**3.4.4 Mechanical tilt.**- Operating parameters, paragraph **3.3.1,** shall be met when the longitudinal axis of the rotary joint is allowed to tilt **+2** degrees from the vertical plumb while aligned to the main pedestal bearing.

**3.4.5 Size limitations.**- The rotary joint shall be compatible with **AB-414** pedestal, **MK-747** and **MK-748** antenna system **AN/FPS-20/60** radar. The pedestal and antenna systems are described in the manuals for the **AN/FPS-20/60** long range radar.

**3.4.6 Finish.**-

**3.4.6.1 RF finish.**- RF portions shall be silver-plated, then rhodium or palladium flash plated if the rotary joint is of brass composition. If aluminum composition is used, then the surface is to be chemically treated in accordance with **1-3.8, FAA-G-2100/1b.** The mating flanges shall be chemically compatible to mate with aluminum waveguide or coax.

**3.4.6.2 External finish.**- All exterior surfaces except **16.125<sup>-</sup>.010** diameter threads and electrical connecting surfaces shall be protectively coated using the following three finishes:

(a) Zinc chromate wash primer per **MIL-C-8514,** thickness **0.2** to **0.3** mils.

(b) Epoxy primer per **MIL-P-23377** or equivalent, thickness **0.7 mil** max.

(c) Polyurethane enamel per **MIL-C-83286B,** Type II, olive drab semi-gloss enamel, thickness **1.4** to **1.8** mils.

Application shall be with airless, electrostatic spray gun.

**3.4.7 Mounting and mechanical interface.**- Each rotary joint shall be furnished with mechanical interfacing hardware (see Figure 2, 6 Path Rotary Joint, Bendix) and shall be compatible with ~~AB-414~~ pedestal, ~~MK-747~~ and ~~MK-748~~ antenna systems.

**3.4.8 Nameplate.**- A nameplate shall be attached to the rotary joint. The nameplate shall be in accordance with paragraph ~~1-3.13~~ of ~~FAA-G-2100/1b~~.

**3.4.9 Materials.**- Finger stock or like material shall not be used as a mechanical/electrical joint that is subject to movement or requires pressure to maintain contact during rotation. All sections shall be designed to be noncontacting. The rotary joint shall have integral bearings and shall not depend on the pedestal for the alignment of the choke joint/s. No DC path is required through the coaxial paths.

**3.4.10 Lubrication.**- Lubrication shall not be required more often than once each six months of operation. The rotary joint shall not require disassembly to accomplish lubrication.

**3.4.11 Noise.**- The noise level as measured within **12** inches directly below the rotary joint shall not exceed **65 dBA** with the rotary joint rotating at 6 RPM.

**3.4.12 Part marking.**- The rotary joint shall be marked in accordance with ~~MIL-STD-1285~~ with the following information as a minimum.

- (a) The actual manufacturer's name, registered trademark, or ~~H4-1~~ Code identification number.
- (b) Date of production in accordance with ~~MIL-STD-1285~~. On parts which are returned by the manufacturer after rework or inspection, the manufacturer shall mark a new date code prefixed by the letter "R" without removal of any prior markings.
- (c) All RF ports and slip ring jacks shall be marked with reference designation, i.e., Channel **1, J1**, etc., with black **0.25** inch high caps.
- (d) A **high** air pressure warning sign shall be marked in red, **0.25** inch high caps, at each waveguide port as follows: WARNING: BLEED AIR PRESSURE BEFORE LOOSENING FLANGE.

**3.4.13 Axial and radial forces.**- The rotary joint shall be designed for operation with an axial force of **50** pounds maximum and a radial force of **150** pounds maximum.

**3.5 Maintainability.**- The rotary joint shall be designed to permit two experienced technicians to readily remove and replace the rotary joint. Lifting eyes shall be appropriately located for handling purposes.

**3.5.1 Inspection and adjustments.-** The design shall be such that any inspections and adjustments necessary to maintain the equipment shall be easily performed.

**3.6 Design review.-** At least one design review shall be held by the manufacturer with the Government prior to the Government's granting authority to manufacture the rotary joint. Two weeks prior-notice-of the design review shall be given to the Government.

**3.7 Reliability/life requirements.-**

**3.7.1 Service life.-** The unit shall be designed and constructed to operate continuously for a period of at least 20 years with the prescribed maintenance and replacement of parts. Bearing life shall be designed to operate continuously for a period of not less than 5 years, if the bearings are field replaceable. If bearings are factory or depot replaceable, life must extend to the service life. All rotating parts, including seals and the slip ring assembly, shall have a life characteristic of at least 50,000 hours with a 95% confidence level. The brush life shall be at least 25,000 hours, without brush adjustment, when operating at 6 RPM.

**3.7.2 Reliability data.-** The reliability data in the form of field data, life test data, or other appropriate reliability data shall be supplied to the Government in order to demonstrate compliance to the service life requirement. The data format shall be subject to Government approval prior to submission.

**4. QUALITY ASSURANCE PROVISIONS**

**4.1 General.-** The contractor shall provide the test facilities, instrumentation, and services, all of which shall be acceptable to the Government, that are required to perform the tests specified herein. Records of tests, including examinations and inspections, shall be complete and available to the Government.' The Government reserves the right to witness or perform any of the tests set forth in this specification when such tests are deemed necessary by the Government to assure that the equipment and services conform to the prescribed requirements. The tests shall be conducted by the contractor to demonstrate compliance with this specification according to the test methods and procedures stated in the Government approved test plan. The contractor shall furnish test plans and procedures which shall detail the time, place, and manner in which the equipment shall be tested. These tests, as a minimum, shall consist of the following:

<u>Test</u>	<u>Reference Paragraph</u>
(a) Quality Control (Inspection)	<b>4.3.1</b>
(b) Preliminary Tests	<b>4.3.2</b>
(c) Design Qualification Tests	<b>4.3.3</b>
(d) Type Tests	<b>4.3.5</b>
(e) Factory Acceptance Tests	<b>4.3.6</b>

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(c) Design Qualification Tests	<b>4.3.3</b>
(d) Type Tests	<b>4.3.5</b>
(e) Factory Acceptance Tests	<b>4.3.6</b>

**4.3.3 Design qualification tests.**- In addition to tests specified in ~~FAA-G-2100/11b~~, the design qualification tests shall include tests to demonstrate conformance with paragraphs 3.2 et seq, 3.3 et seq., and 3.4 et seq of this specification. In addition, a factory run-in test of 168 hours with the unit mounted in its normal operating configurations shall be conducted to determine if any electrical/mechanical difficulties exist. The run-in test shall be at 6 RPM. Any failures shall be corrected and the 168-hour test shall be run without failures.

**4.3.4 Specific tests.**- Tests shall demonstrate compliance with requirements of 3.2, 3.3 and 3.4 of this specification and shall include, as a minimum, the following tests:

(a) Electrical tests for Sections 1, 2, 3 (radar) and Sections 4, 5, and 6 (ATCRBS beacon)

\*Power handling capability (paragraphs 3.3.1b and 3.3.1e)

Passband VSWR (paragraph 3.3.1e)

VSWR, maximum change for 360° rotation (paragraph 3.3.1f)

Phase shift (paragraph 3.3.1g)

Attenuation (paragraph 3.3.1h)

Isolation (paragraph 3.3.2)

Tests of beacon paths at 1026, 1030, 1034, 1085, 1090, 1095 MHz for design qualification tests and type tests (paragraph 3.3.1, Note 1)

Tests of beacon paths at 1030 and 1090 MHz for factory acceptance tests (paragraph 3.3.1, Note 1)

Tests of phase and insertion loss tracking (sections 4 and 5 and sections 4 and 6) for design qualification tests and factory acceptance tests (paragraph 3.3.1, Note 1)

Tests of pulse shape and pulse shape tracking (sections 4 and 6) for design qualification and type testing (paragraph 3.3.1, Note 1)

(b) Mechanical and visual tests for Sections 1, 2, 3 (radar) and Sections 4, 5, and 6 (ATCRBS beacon)

Waveguide pressure (paragraph 3.4.1)

RF Connections (paragraph 3.4.2)

Slip rings (paragraph 3.4.3)

Mechanical tilt (paragraph 3.4.4)

Size limitations (paragraph 3.4.5)

Legend

\* These tests to be performed on first production unit only.

4.3.5 Type tests.- Type tests shall be performed on the first production unit and other units selected by the Government in accordance with **FAA-G-2100/1b**. These tests shall demonstrate compliance with all of the requirements of this specification and shall include all tests to demonstrate compliance with paragraph **4.3.4** of this specification including a factory run-in test of **168** hours.

The type tests shall be performed under the service conditions, as described in paragraph **3.2.1** et seq, while subjecting the equipment to the temperature and humidity test procedures designated as steps 1 through 8 under paragraph **1-4.12** of **FAA-G-2100/1b**, on only those equipment to be type tested.

4.3.6 Factory acceptance tests.- Production testing and inspection of subsequent units shall be in accordance with paragraph **1-4.3.4** of **FAA-G-2100/1b** and established procedures, and shall be conducted to insure compliance under normal test conditions with all of the requirements of this specification and shall include all of the tests described in paragraph **4.3.4** herein. Paragraph **3.3** shall be demonstrated using low power measuring techniques performed at a minimum of every **25 MHz** (**5** frequencies) within the frequency bands. A factory run-in test of **168** hours shall be performed on each unit.

5. PREPARATION FOR DELIVERY

5.1 Preservation, packaging, and packing.- Each unit package shall be individually preserved, packaged, and packed in accordance with **MIL-E-17555**, Level **C**.

5.2 Marking for shipment.- Each unit package shall be marked in accordance with **MIL-STD-1299**, with the following information:

- (a) Nomenclature
- (b) Notation "MFR" followed by the actual manufacturer's name, registered trademark, or **H4-1** Code identification number
- (c) FAA Type number
- (d) Serial Number (Sequential)
- (e) Date of production in accordance with **MIL-STD-1285**

6. NOTES

6.1 Notes.- None.

4.3.5 Type tests.- Type tests shall be performed on the first production unit and other units selected by the Government in accordance with **FAA-G-2100/1b**. These tests shall demonstrate compliance with all of the requirements of this specification and shall include all tests to demonstrate compliance with paragraph **4.3.4** of this specification including a factory run-in test of **168** hours.

The type tests shall be performed under the service conditions, as described in paragraph **3.2.1** et seq, while subjecting the equipment to the temperature and humidity test procedures designated as steps 1 through 8 under paragraph **1-4.12** of **FAA-G-2100/1b**, on only those equipment to be type tested.

4.3.6 Factory acceptance tests.- Production testing and inspection of subsequent units shall be in accordance with paragraph **1-4.3.4** of **FAA-G-2100/1b** and established procedures, and shall be conducted to insure compliance under normal test conditions with all of the requirements of this specification and shall include all of the tests described in paragraph **4.3.4** herein. Paragraph **3.3** shall be demonstrated using low power measuring techniques performed at a minimum of every **25** MHz (**5** frequencies) within the frequency bands. A factory run-in test of **168** hours shall be performed on each unit.

5. PREPARATION FOR DELIVERY

5.1 Preservation, packaging, and packing.- Each unit package shall be individually preserved, packaged, and packed in accordance with **MIL-E-17555**, Level **C**.

5.2 Marking for shipment.- Each unit package shall be marked in accordance with **MIL-STD-129**, with the following information:

- (a) Nomenclature
- (b) Notation "MFR" followed by the actual manufacturer's name, registered trademark, or **H4-1** Code identification number
- (c) FAA Type number
- (d) Serial Number (Sequential)
- (e) Date of production in accordance with **MIL-STD-1285**

6. NOTES

6.1 Notes.- None.

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